Space Weather Technical Forecast

Issued on Friday, 08 March 2024 at 12:39 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storm in next 24 hours. Now reduced daily Slight Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured by GOES16 and 18, showed occasional low-level C-class flares that became fewer and further between as the period progressed, with the background X-ray flux falling into B-class into the current UTC day. The peak flare of the period was a C6.3 at 07/1207UTC from AR3599 near centre-disc. This is one of up to six numbered sunspot regions on the facing side at present, but is the only group showing any real complexity. AR3599 is currently analysed as a Dai/Beta-Gamma-Delta, although its trend in recent hours has been of decreasing penumbral area and a reduction in the number of Mt Wilson Delta spot candidates. The only other active region to show any significant changes was AR3605 to its immediate southeast, which showed a spreading trend in its simple bipolar configuration.

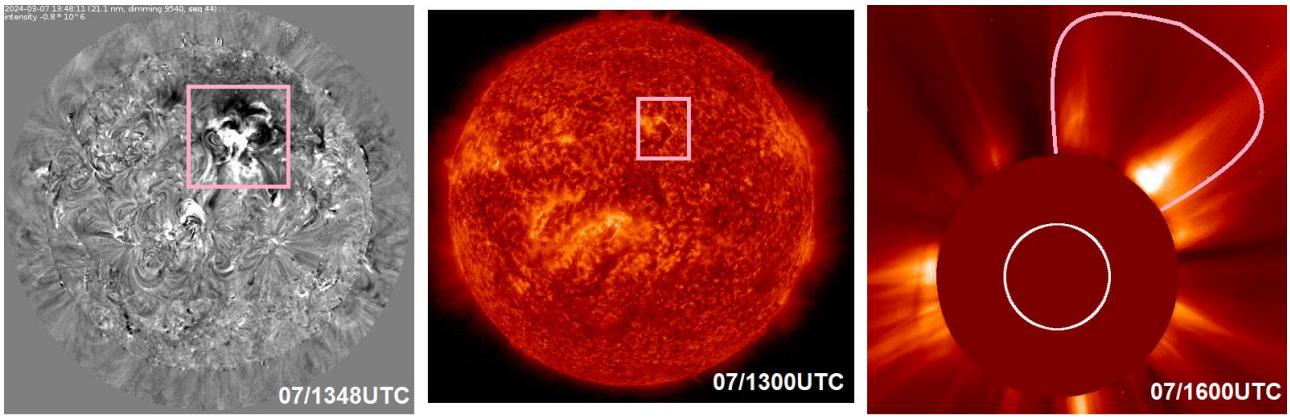

Figure 0: three-up of northwest quadrant coronal dimming (processing by SIDC ROB); possibly tied EUV filament lift-off footprint in AIA304; and tenuous resultant ejecta on Lasco C2 (faint and separated possible CME elements within the pink envelope shown).

One of the more noteworthy events in the period was a small emission from the vicinity of AR3602 in the northwest quadrant around 07/1300UTC (seen in AIA304 for example). This was followed by an areally-extensive coronal dimming, although the rate at which this occurred was slow. There was little resulting on coronagraphs, however a few assessments as to possible Coronal Mass Ejections (CMEs) have been made, with the result(s) being a possible weak glancing blow in the UTC morning of 11 March, with a most likely 1AU crossing time of 11/0600UTC.

Other events in the period included Type II radio emissions at 07/2321UTC with an estimated speed of 904km/s; and 08/0340UTC with 1242km/s (which also came with a Type IV). Both of these events were from immediately over the northwestern limb and the associated CMEs have no Earth-directed component. In addition, no solar radiation storms resulted. A potential filament eruption was noted late in the current 24-hour period (e.g. on AIA304, H-Alpha) leaving the

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northeastern disc around 08/1100UTC. Coronagraph imagery for this final potential event is awaited.

Solar Wind / Geomagnetic Activity: Solar wind parameters observed by ACE/DSCOVR at L1 suggested Earth has now entered a fast solar wind environment. This is thought most likely to be the high speed stream from coronal hole 03, with the phi angle accordingly mostly negative (towards the Sun).

The solar wind speed rose successively in the period: starting near background and 375km/s, it underwent a minor enhancement to 425 after 1830UTC, and again at 08/0320UTC to an eventual peak near 525. The solar wind density generally fell away with each new enhancement, although it remained within single figures ppcc throughout. The IMF peaked at 8nT prior to the 1830UTC changes, while the north-south component was changeable between +6 and -7nT.

The net result of the above solar wind measures was for provisionally mostly Unsettled geomagnetic activity, peaking at Active Kp '3+' in the 18-21UTC interval.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at Background levels.

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background to Moderate levels with a peak at 178pfu at 07/1605UTC. The associated 24 hour fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 08/0001UTC was 1.9e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Expected to remain generally low with a Slight Chance of an isolated M-class flare, mainly from AR3599. No significant regions leave or arrive in the period, meaning the trend is flat.

Solar Wind / Geomagnetic Activity: A CME that left the Sun on 05 March may give a glancing blow later in the current UTC day (Friday 08 March) or into early Saturday. A second CME mentioned above may now also give glancing influence early on Monday 11 March, although this event is of lower confidence.

Earth is otherwise now showing fast wind influence, with Elevated solar winds now in course. These should ease later in the coming UTC weekend and into the new working week.

All considered, initially Unsettled geomagnetic activity carries a Chance of rising to Minor Storm G1 should the 05 March CME arrive earlier in the next 24 hours, else the risk lessening due to the slower speeds involved and the smaller overlap with CH06's fast wind. A second CME then perhaps rounds out the four days with a Slight Chance of G1 on Monday 11 March.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to persist at Background levels.

GOES16 high energy electron flux is expected to remain at mainly Normal Background levels, with the associated 24-hour fluence remaining below the Active threshold.

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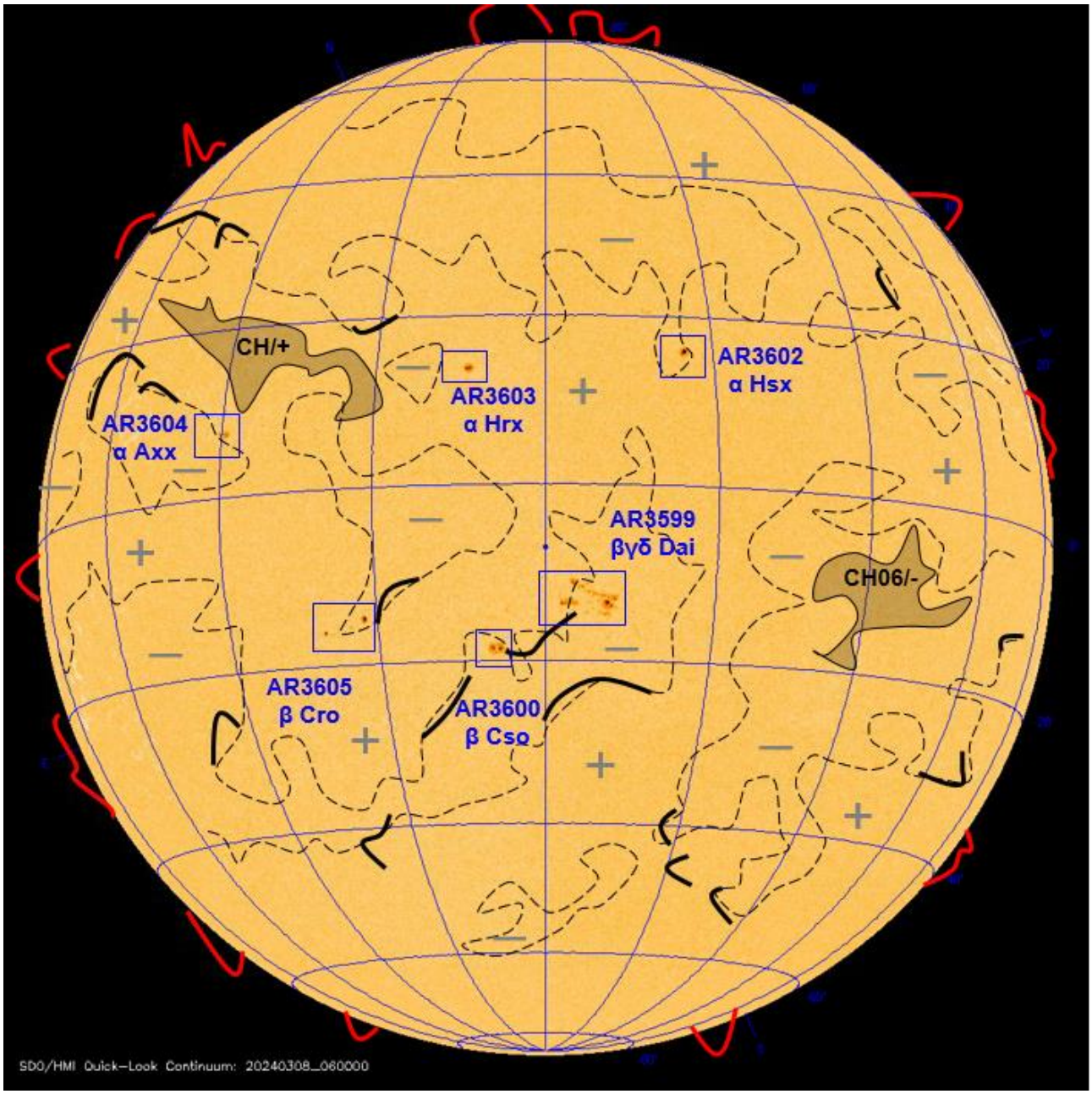
Figure 1. Solar Analysis Valid 08/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The forecast now comprises an incumbent fast wind regime from CH06/- and up to two CMEs: from 05 and 07 March.

The fast wind currently being sampled by Earth is considered most likely to be that stemming from CH06/-, and current solar wind speeds are perhaps hinting that they are near their peak given the closing IMF magnitude to nearer 5nT from a peak of 8, and the density falling away. Peak geomagnetic activity is therefore perhaps already past its peak, although possible inbound

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CMEs in the flow may alter the typical evolution of the high speed stream.

The first of the CMEs in the forecast originated from a filament lift off in the southeast on 05 March, and has been assessed as providing a risk of a glancing blow inside the next 24 hours, although the majority of the CME is expected to pass below and behind Earth's orbit.

There is now also a second possible glancing blow in the forecast from the northwest-central dimming seen around 07/1300UTC. Confidence is notably low surrounding this event, however there is perhaps a Slight Chance of G1 peaking around 11/0600UTC. MOSWOC Enlil modelling is suggesting an erroneous fast wind as due around this time which will likely unduly accelerate any nested CMEs and reduce their transit times to Earth - this suggested arrival time does try to account for this.

All considered, initial Unsettled activity in the fast wind may give way to a peak Chance of G1/Minor Storm in the next 24 hours due to the glancing CME from 05 March. Geomagnetic activity should then ease for a time to Quiet later in the UTC weekend as the fast wind similarly eases, perhaps with a final Slight Chance of G1 rounding out the four days should the 07 March CME affect Earth.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	25	20	1	10
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0210	Partial	Filament Eruption	SE	790km/s	09/0001UTC	Glancing blow
07/2215	Partial?	Dimming, filament?	NW central	386	11/0600UTC	Low confidence, glancing blow

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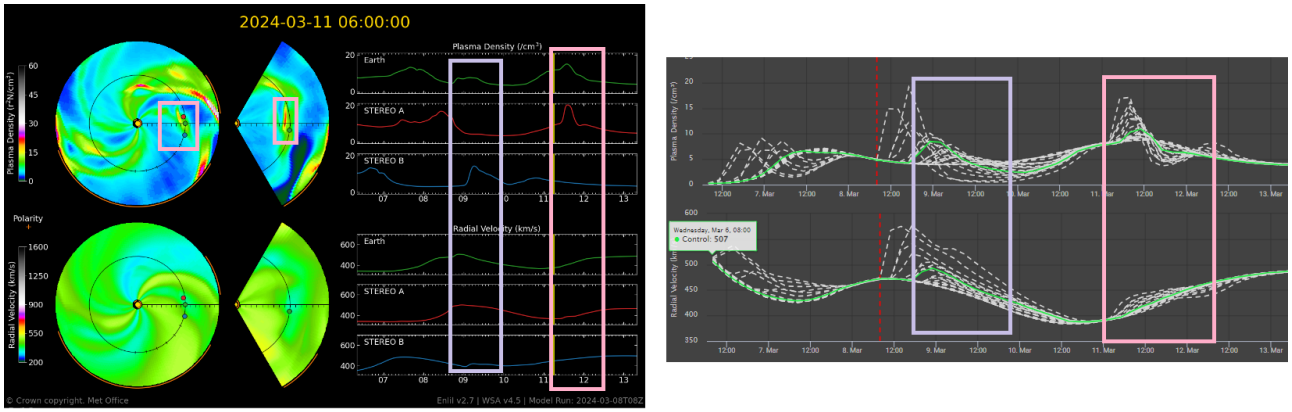
Figure 2: Latest MOSWOC Enlil run (badge time 08/0800UTC), paused at 1AU crossing time of the 07 March NW-central dimming CME. This feature is shown boxed pink, with the earlier CME from 05 March boxed lilac. Note that this CME's forecast arrival time is not purely based on Enlil output, but also other MOSWOC advisors runs. Note also that Enlil has an inbound southern solar hemipshere fast wind around this time that is not expected in reality.



Radio Blackouts - X-Ray Flares:

The current Earth-facing disc is mostly devoid of potent sunspot regions, and the one exception to this, AR3599, has shown some signs of a simplifying trend in the past 24 hours. These have included the fading of at least one of its Mount Wilson delta spot candidates, as well as a reduction in penumbral area.

The fortunes of the disc are largely tied to this one spot group, and may prove volatile near present levels as a result, but on current evidence they have been lowered to a daily Slight Chance for M-class. This sunspot group remains on the visible disc throughout the coming four days, and far-side soundings do not currently suggest any major oncoming regions as due during the period, meaning the overall risk is held constant.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	20	20	20	20
Very Active	**R3 to R5 X Class**	No	1	1	1	1

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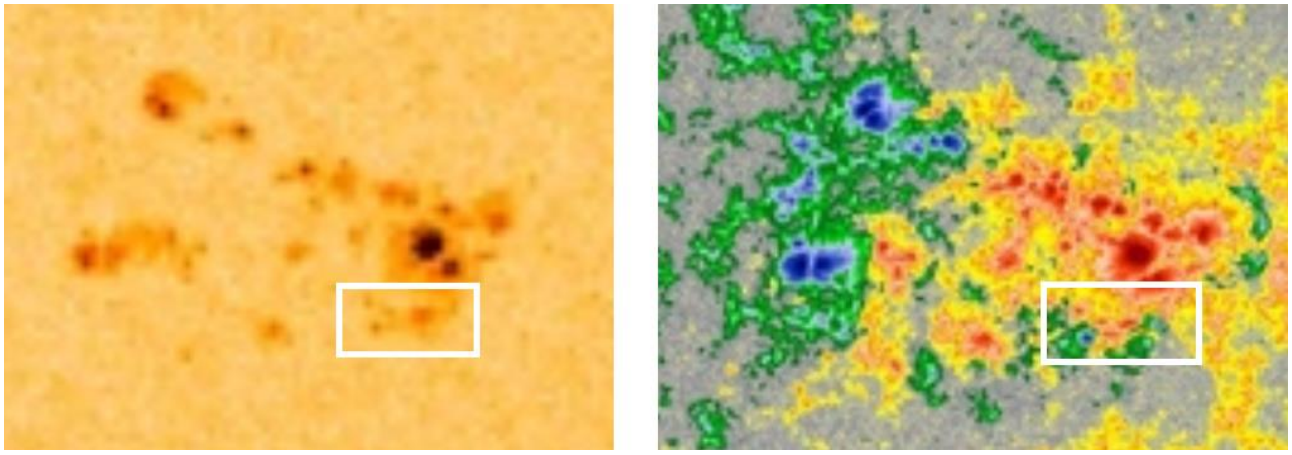
Figure 3: Sunspot region AR3599 as it appeared in HMIIF and HMIBC at 08/1200UTC, showing the one remaining potential mount Wilson delta boxed in white.



Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux is currently at Background levels. No recent enhancements have been noted anywhere on the disc, including northwest limb activity of the past 24 hours. Despite this, this off-going part of the facing side of the Sun is perhaps responsible for the bulk of any S1+ risk in the first half of the period, later transitioning to AR3599 as it makes its way well onto the western side of the Sun into the coming new UTC week. The net result is a roughly constant Slight Chance of S1+, as the west limb contribution fades as a counterpoint to AR3599's increase.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has varied between Normal Background and Moderate levels, and is expected to remain so through much of the forecast period. The main drivers for any change to the current steady state are the arriving fast wind regime and then up to two CMEs.

The fast wind regime from CH06/- appears to be plateauing near 500km/s. The peak potency of this feature is rendered more difficult to assess as it was not present on last rotation, however the possibility of further slight rises in solar wind speed is the rationale for the very slight increase in risk into the coming UTC weekend. This will be complicated by the possible 05 March CME arrival early in this timeframe, which may delay any peak response until later in the weekend, ahead of a further possible redistribution of electrons come Monday 11 March should the 07 March CME arrive.

The presence of up to two transients in the period now renders MOSWOC REFM less useful, however the most likely forecast remains a continuation of the now long-term habit of sub-Active 24-hour integrated electron fluence.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	5	10	5
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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